

A Case–Control Study on Food Frequency and Meal Pattern Distribution in Coronary Artery Disease Patients Attending Tertiary Care Teaching Hospitals

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Abstract

Context: Coronary artery disease (CAD) is the blockage of coronary arteries, usually consequent to atherosclerosis. CAD is a lifestyle disease with an increasing disease burden in society. Evaluation of risk factors for CAD is crucial for its prevention. Lifestyle components like calorie consumption chronology, saturated fatty acid (SAFA) intake, reclining time, nocturnal eating and intermittent fasting were considered. **Aims:** To correlate calorie distribution, SAFA intake, reclining time, nocturnal eating and intermittent fasting with occurrence of CAD. **Study Design/Materials and Methods:** A case-control study consisting of 235 cases and 185 controls. Questionnaire was self-designed according to NIN guidelines. Study was ICMR funded and data analysis was done using Microsoft Excel and IBM SPSS. **Results:** Across case and control groups, total calorie consumption difference was insignificant ($P = 0.42$). Calories consumed in breakfast slot ($P = 0.001$) and dinner slot ($P = 0.003$) were significantly different possibly due to discrepancy among circadian variation in insulin sensitivity and calorie consumption distribution. Reclining time <1 h in afternoon (odds ratio [OR] = 2.24, 95%, 1.481–3.356) and night (OR = 2.05, 95% confidence limit [CL], 1.233–3.410), SAFA consumption (OR = 2.006, 95% CL, 1.214–3.316), intermittent fasting (OR = 1.748, 95% CL, 0.997–3.067) and nocturnal eating (OR = 1.291, 95% CL, 0.779–2.141) are potential risk factors. **Conclusions:** Calorie consumption chronology, SAFA intake, Reclining time, Nocturnal eating and intermittent fasting emerged as significant risk factors.

Keywords: Calorie distribution, coronary artery disease, nocturnal eating, reclining time

INTRODUCTION

Coronary artery disease (CAD) is the impedance or blockage of one or more arteries that supply blood to the heart usually due to atherosclerosis. Overall prevalence of CAD among adults based on the clinical and electrocardiogram (ECG) criteria is currently estimated as 9.7% and 2.7% in the urban and rural populations, respectively.^[1,2,3] Qualitative and quantitative aspects of meal consumption can have significant implications on prevention and prognosis of CAD. Incidence of CAD is higher in people following western diet than those following Mediterranean diet, hence.^[3,4,5,6,7] Circadian rhythm is governed by the perception of light; and the peripheral clocks of the body are governed by food intake,^[5,8,9] any disturbance between the coordination of these factors could lead to increased risk of CAD. Such disturbances are possible by alterations in meal patterns such as breakfast skipping and intermittent fasting (“Calorie restriction for more than fifteen

hours continuously in one day”).^[5,8,9,10,11,12] Time interval between meal and sleep (“Reclining Time”) and nocturnal eating (“Calorie consumption after dinner and before sleeping most commonly in form of snacks”) has significant correlation with digestion of food.^[13] Meal satiety also varies with time of day and that food intake during the night is less satiating and leads to greater daily caloric intake compared to morning hours.^[6] Night-shift workers have a higher prevalence of overweightness, abdominal obesity, elevated triglycerides, dyslipidemia, impaired glucose tolerance, and decreased kidney function compared to day workers.^[14,15] Reduction in

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intake of saturated fatty acid (SAFA) does not significantly decrease the incidence of CAD, rather when it was replaced by poly unsaturated fatty acid (PUFA); a significant decrease in risk of CAD was observed.^[16,17] Hence a study considering the above risk factors was conducted.

MATERIALS AND METHODS

This case-control study assessed meal pattern distribution associated with occurrence of CAD in diagnosed cases of CAD or Myocardial infarction visiting tertiary care hospitals. After obtaining the institutional ethical clearance the study was conducted for a period of 6 months starting from March 10, 2019 to September 10, 2018. Two tertiary care hospitals were included one private and one government institute. Government and private institutes were included to accommodate a wide socioeconomic strata. Patients visiting the outpatient department (OPD) and those admitted in the intensive coronary care unit (ICCU) and medical wards were enrolled in the study and a dietary questionnaire based on National Institute of Nutrition (NIN) guidelines was administered in each subject after obtaining consent. A 24 h dietary recall method mentioned in NIN guidelines was adopted. The questionnaire included past 24 h dietary history in each OPD patient and routine dietary history in indoor patients. Confidentiality was maintained during the study. The cases and control were selected on the basis of consent given, diagnosis of CAD (cases) and ruling out CAD (control), >40 years age, ruling out mental instability. The patients refusing to give the consent and that of altered mental status were not included. All patients diagnosed or being treated under a cardiologist in ICCU and cardiology OPD for CAD using Angiography, ECG and Echocardiography were selected as subjects. Patients attending the OPD services of the hospital were selected as controls after matching socio-demographic data and clinical details and ruling out CAD in the selected individuals. All the dietary parameters were measured on weekly and daily basis in normal routine life of the subjects and frequency of each was obtained. Various clinical and sociodemographic parameters such as age, gender, occupation, co morbid illness and addiction history were considered to facilitate matching between both groups. Data was collected using questionnaire with three parts: Part 1: Sociodemographic details, Part 2: Clinical history, Part 3: dietary details (according to “NIN guidelines”).^[18] Calorie consumption pattern along with oil and fat intake were recorded (weekly and daily basis). Confounding factors such as recent hospitalizations, recent dietary changes, or any other parameter limiting the target of this study were eliminated as subjects. Also incomplete questionnaires were also excluded. The data were compared between case and control groups after limiting confounding factors. As the data was purely based on subject's compliance and recall this study was limited by subjective bias and recall bias. Sample size was 420 with 235 in case (males = 195, females = 40) and 185 in control (males = 152, females = 33) group and was obtained during a time period of 6 months. In this “Time

bomb” study all cases and controls visiting the selected tertiary care teaching hospitals during the study duration of 6 months were selected and enrolled. Each subject after being diagnosed or treated by a cardiologist for CAD was selected as a case after obtaining consent. Controls were selected by ruling out CAD and obtaining consent. All incomplete forms ($n = 50$) were excluded in data entry and analysis. All forms which had important data (“sociodemographic, clinical or dietary.”) missing in any of the three parts of the questionnaire or did not fulfill the matching and inclusion criteria were excluded as subjects. Quantitative variables obtained were coded and were entered in Microsoft Excel 2013 and results were derived using IBM SPSS software (IBM Statistical Package for the Social Sciences, Armonk, New York, United States of America). Various statistical tests such as odds ratio (OR), Chi square, Unpaired *t*-test, Spearman and Pearson correlations, frequency tables, crosstabs, mean and median were adopted. Matching was done using sociodemographic and clinical history. All tests were performed at 95% confidence limit (CL) [Figure 1].

RESULTS

It is a case-control study of 420 people (cases: 235, controls: 185). The mean age in case and control group was 57.86 ± 10.112 and 57.19 ± 10.714 respectively. All individuals enrolled in the study were aged between 40 years and 75 years. The median age in both groups was 57. The case and control group had 40 females-195 and 33 females-152 males respectively. In the case group 67.7% had no addiction, 2.6% were chronic alcoholics, 7.2% were chronic smokers, 13.6% were chronic tobacco chewers and 9%-more than one addictions while in the control group 64.3% had no addiction, 2.7% were chronic alcoholics, 5.4% were chronic smokers, 16.2% were chronic tobacco chewers and 11.4%-more than two addictions [Table 1]. In the case group 7.2% had a family history of CAD, 9.4% of DM, 10.6% of HT, while 8.1% had a positive family history of two or more than two risk factors mentioned above. Family history in control group was positive in 1.6% for CAD, 7.6% for DM, 13% for HT and 2.7% for two or more than two risk factors mentioned above [Table 2]. In case and control group 5.1% and 8.6% were diabetics, 7.7% and 14.1% were

Table 1: Personal history

| | Frequency (%) | |
|-------------------|---------------|-------------|
| | Cases | Control |
| No addiction | 159 (67.7) | 119 (64.3) |
| Alcohol | 6 (2.6) | 5 (2.7) |
| Smoking | 17 (7.2) | 10 (5.4) |
| Tobacco | 32 (13.6) | 30 (16.2) |
| Alcohol + tobacco | 6 (2.6) | 4 (2.2) |
| Alcohol + smoking | 5 (2.1) | 7 (3.8) |
| Smoking + tobacco | 10 (4.3) | 10 (5.4) |
| Total | 235 (100.0) | 185 (100.0) |

In the case group 67.7% of the total people have no kind of addiction, 2.6% are chronic alcoholics, 7.2% are chronic smokers, 13.6% are chronic tobacco chewers and 9% people have more than one addictions

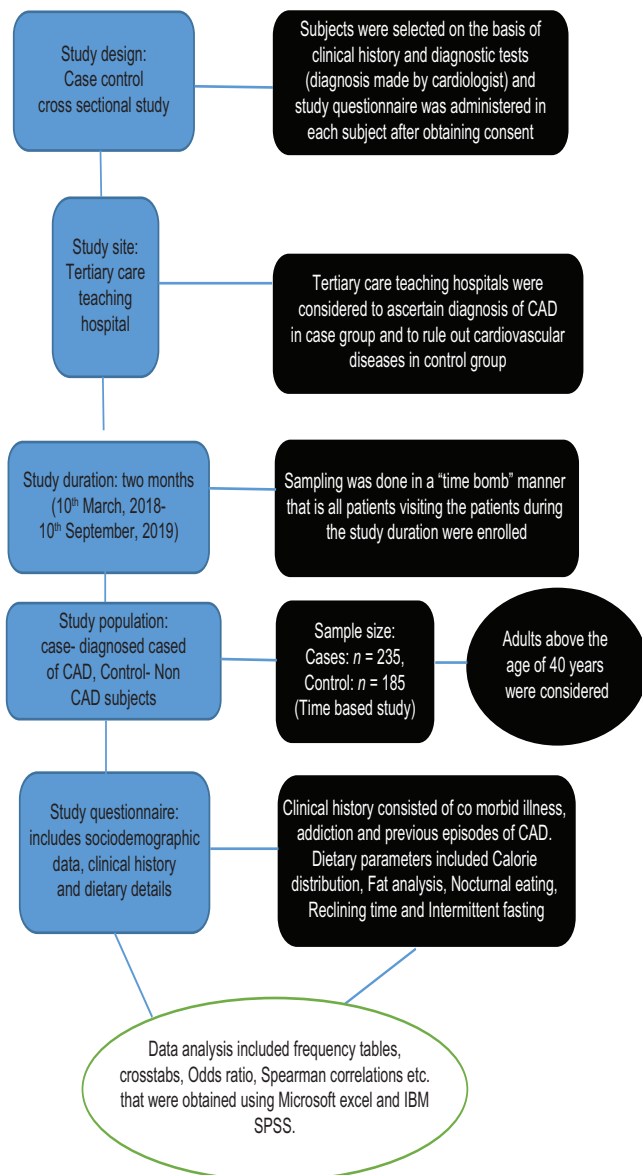


Figure 1: Methodology

hypertensives, 19.7% and 7% had two co-morbid illnesses and 5.5% and 1.1% had more than two co-morbid illnesses respectively [Table 3]. In the comparison of calorie distribution in the case and the control group a statistical significant difference is found in the breakfast slot 4:00 am–10:00 am ($P = 0.001$) and dinner slot 16:00–22:00 ($P = 0.003$). In contrast there is little significant difference in time slots 10:00 am–16:00 and 22:00–4:00 am [Table 4]. The fat analysis show that 64 out of 235 individuals consume oil rich in SAFA and poor in PUFA in the case group while 33 out of 185 individuals do so in control group ($OR = 2.006$, 95% CL, 1.214–3.316). SAFA intake was estimated qualitatively consisting of the brand and type of edible oil consumed by both population. Furthermore frequency of ghee and butter intake was also measured. Content of SAFA was obtained from standardized charts and compared in both groups.^[26] In the case group 47 out of 235 people have a habit of nocturnal eating whereas in the control group 30 out of 185

individuals have a habit of nocturnal eating ($OR = 1.291$, 95% CL, 0.779–2.141). In the case group Reclining time (afternoon) is <1 h in 111 people and is more than 1 h in 124 people. In the control group it is <1 h in 53 people and more than 1 h in 132 people ($OR = 2.24$, 95%, 1.481–3.356). In the case group reclining time (night) is <1 h in 59 people and is more than 1 h in 176 people. In the control group it is <1 h in 26 people and more than 1 h in 159 people ($OR = 2.05$, 95% CL, 1.233–3.410). In the case group 43 out of 235 individuals have a habit of intermittent fasting while in the control group 21 out of 185 individuals have a habit of intermittent fasting ($OR = 1.748$, 95% CL, 0.997–3.067).

DISCUSSION

Calorie distribution

Total calorie intake for an entire day of each subject was analyzed. No statistically significant difference was found ($P = 0.420$) in overall calories consumed daily between case and control groups.^[4,12,13] Thus, the effect of total dietary intake seems to have no significant effect on cardiovascular health. Hence chronology of the calorie intake was considered. Calorie intake of all the participants was calculated during four time slot. The results suggest that individuals having less calorie intake during breakfast slot significantly increase risk of CAD ($P = 0.001$). A positive correlation was obtained between increased calorie intake in the breakfast slot and preserved cardio-metabolic health ("Pearson correlation = +0.134, alpha error = 0.01"). People consuming greater amount of calories during dinner slot showed a greater occurrence of CAD ($P = 0.003$). A negative correlation was obtained between increased calorie intake in the dinner slot and preserved cardio-metabolic health ("Pearson correlation = −0.105, alpha error = 0.01"). Sharma *et al.* has documented how breakfast skipping increases the risk of CAD by 34% and that it emerged as stronger risk factor than obesity and sedentary life style in Indian population and showed close association with presence of hypertension.^[9] Our findings are thus, consistent with previous study conducted in the same target population. Breakfast skipping and taking lower calorie intake during morning hours of 04:00 to 10:00 can increase the risk of CAD. Thus the diurnal variation of glucose tolerance and circulating free fatty acid (FFA) levels appears to be responsible for the same. Insulin sensitivity is significantly higher in the morning than the evening. It has been demonstrated that evening insulin response pattern in normal subjects resembles to that of a diabetic patient.^[8,10] Having frequent meals outside of the high insulin sensitivity phase of the day might expose the patient on a daily basis to a transient phase of adverse metabolic conditions leading to CAD. Having greater part of the daily calories within the 'high' insulin sensitivity phase can prevent a period of increase in circulating FFA levels, thereby protecting against progression of CAD.^[8,9,10] Also circadian misalignment leads to metabolic instability. Thus calorie distribution appears to be a more important marker of cardio metabolic health rather than the

Table 2: Family history

| | Frequency (%) | |
|----------------|---------------|-------------|
| | Cases | Control |
| No risk factor | 152 (64.7) | 139 (75.1) |
| CAD | 17 (7.2) | 3 (1.6) |
| DM | 22 (9.4) | 14 (7.6) |
| HT | 25 (10.6) | 24 (13.0) |
| DM + HT | 11 (4.7) | 5 (2.7) |
| DM + CAD | 4 (1.7) | 0 (0.0) |
| HT + CAD | 3 (1.3) | 0 (0.0) |
| CAD + DM + HT | 1 (0.4) | 0 (0.0) |
| Total | 235 (100.0) | 185 (100.0) |

In the case population 7.2% people have a family history of CAD, 9.4% people of DM, 10.6 of HT and 7.7% people have two genetic risk factors while only 0.4% have more than two genetic risk factors. CAD: Coronary artery disease, DM: Diabetes mellitus, HT: Hypertension

Table 3: Co-morbid illness

| | Frequency (%) | |
|-----------------------|---------------|-------------|
| | Cases | Cases |
| No co-morbid illness | 78 (33.2) | 126 (68.1) |
| DM | 12 (5.1) | 16 (8.6) |
| HT | 18 (7.7) | 26 (14.1) |
| Dyslipidemia | 68 (28.9) | 2 (1.1) |
| DM + HT | 10 (4.3) | 0 (0.0) |
| DM + dyslipidemia | 14 (6.0) | 12 (6.5) |
| HT + dyslipidemia | 22 (9.4) | 1 (0.5) |
| More than two illness | 13 (5.5) | 2 (1.1) |
| Total | 235 (100.0) | 185 (100.0) |

In the case group 33.2% people have no co morbid illness, 5.1% people have DM, 7.7% people have HT, 28.9% people have dyslipidemia, 19.7% people have two co-morbid illnesses and 5.5% have more than two co-morbid illnesses. DM: Diabetes mellitus, HT: Hypertension

Table 4: Calorie distribution

| Calorie intake timing | Mean \pm SD | | P (unpaired t-test) |
|-----------------------|----------------------------|-------------------------------|---------------------|
| | Calorie intake (Kcal) case | Calorie intake (Kcal) control | |
| 4:00-10:00 | 461.09 \pm 199.05 | 528.35 \pm 204.84 | 0.001 |
| 10:00-16:00 | 814.60 \pm 213.62 | 757.15 \pm 158.43 | 0.094 |
| 16:00-22:00 | 809.96 \pm 199.40 | 781.00 \pm 190.59 | 0.003 |
| 22:00-4:00 | 82.87 \pm 179.27 | 73.78 \pm 175.67 | 0.603 |

In the comparison of calorie distribution in the case and the control group a statistical significant difference is found in the time slot 4:00 am–10:00 am ($P=0.001$) and time slot 16:00–22:00 ($P=0.003$). In contrast there is little significant difference in time slots 10:00 am–16:00 and 22:00–4:00 am. P value was calculated using unpaired t -test. SD: Standard deviation

diet type or amount of total calories consumed daily.^[17,19,20] There is a long fasting time before the breakfast slot mainly due to sleep often leading to hypoglycemic state on waking up. Hence not compensating the glucose deficit by skipping breakfast can cause metabolic disturbances^[21] and circadian misalignment^[22] often speeding the atherosclerotic process.

Oil and fat analysis

A risk of developing CAD in association with increased consumption of oil rich in SAFAs (OR = 2.006, 95% CL, 1.214–3.316). 26% consumed groundnut oil in the cases as compared to 15% in controls. Groundnut oil has high concentration of SAFA and poor concentration of PUFA. Reduction in intake of SAFA does not significantly decrease the incidence of CAD, rather when it is replaced by PUFA; a significant decrease in risk of CAD was observed.^[16,23,24] Increased SAFA consumption leads to greater turnover of fat in body leading to obesity and hypertension hastening the atherosclerotic process.

Nocturnal eating

Nocturnal eating as defined as calorie consumption most commonly snacks after dinner and before sleeping. Nocturnal eating increased risk by 29.1% of CAD (OR = 1.291, 95% CL, 0.779–2.141). These results are in accordance with the study that in healthy adults, meal satiety also varies with time of day and that food intake during the night is less satiating and leads to greater daily calorific intake as compared to morning hours.^[14] Also due to diurnal secretion of insulin the insulin sensitivity during night hours is similar to that of a diabetic person hence calories consumed during late night could worsen cardio-metabolic health.^[8,10]

Reclining time

Reclining time is defined as the time interval between meal and sleep. The groups were formed by dividing the population into people having reclining hours less than one and people having reclining hours more than one. After comparison the results showed significant statistical difference in afternoon (OR = 2.24, 95%, 1.481–3.356) and in night (OR = 2.05, 95% CL, 1.233–3.410). Thus it could be said that people going to sleep within 1 h of having meal showed a greater occurrence of CAD and can be considered as a risk factor. There could be many possible reasons that would lead to such a finding. Disturbed gastric emptying^[13,14,25] and greater propensity for sedentary life style in those having a shorter reclining time may be the reason for this increased occurrence. Gastroparesis due to reclining worsens metabolic profile by causing insulin resistance, dyslipidemia and malabsorption. Also skipping meals in the morning could lead to increased calorie intake during lunch and thereby worsening postlunch dip and reduced reclining time and increasing cardio-metabolic risk.

Intermittent fasting

Intermittent fasting is defined as more than 15 h of continuous calorie restriction in 1 day. Intermittent fasting is considered as a healthy approach in the western countries but in Indian population intermittent fasting is often consequent to religious beliefs rather than dietary goals therefore the results obtained are quite contrary. The results showed association of occurrence of CAD with intermittent fasting (OR = 1.748, 95% CL, 0.997–3.067). These results may be due to an increased calorie intake prior to or after the fast. This could be explained by the study that disturbance in the coordination

of the circadian rhythm and the peripheral clocks which are governed by intake of food.^[20] Thus intermittent fasting could be considered a risk factor as far as CAD is concerned as it disturbs the chronology of calorie intake.

CONCLUSIONS AND LIMITATIONS

Increasing burden of CAD in the society especially the urban areas could be prevented at the primary level by intervention in the chronology of the dietary habits. Calorie distribution with maximum calories consumed during the dinner slot, oil rich in SAFA and poor in PUFA, Nocturnal eating, Reclining time <1 h and intermittent fasting mainly on religious grounds increased the risk of CAD and other comorbid illnesses worsening the cardio-metabolic prolife. The study was limited by small sample size, selective bias and recall bias. Dietary variations due to morbidity also limited the scope of the study. Future studies with larger sample size are recommended as rural population, young CAD cases, patients aged more than 75 years of age were not included. Inclusion of above-mentioned population will produce results for a bigger population.

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Conflicts of interest

There are no conflicts of interest.

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